Clouds and the Earth's Radiation Energy System (CERES)
Product Short Name (PSN) Collection Document

CERES logo goes here

Summary

The Clouds and the Earth's Radiant Energy System (CERES) is a key component of the Earth Observing System (EOS). The CERES instrument provides radiometric measurements of the Earth's atmosphere from three broadband channels: a shortwave channel (0.3 - 5.0 microns), a total channel (0.3 - 100mm), and an infrared window channel (8-12mm). The CERES instruments are improved models of the Earth Radiation Budget Experiment (ERBE) scanner instruments, which operated from 1984 through 1990 on the National Aeronautics and Space Administration's (NASA) Earth Radiation Budget Satellite (ERBS) and on the National Oceanic and Atmospheric Administration's (NOAA) operational weather satellites NOAA-9 and NOAA-10. The strategy of flying instruments on Sun-synchronous, polar orbiting satellites, such as NOAA-9 and NOAA-10, simultaneously with instruments on satellites that have precessing orbits in lower inclinations, such as ERBS, was successfully developed in ERBE to reduce time sampling errors. CERES continues that strategy by flying instruments on the polar orbiting EOS platforms simultaneously with an instrument on the Tropical Rainfall Measuring Mission (TRMM) spacecraft, which has an orbital inclination of 35 degrees. The CERES instruments fly on the TRMM spacecraft, the EOS-AM platforms, and on the EOS-PM platforms. The TRMM satellite carries one CERES instrument while the EOS satellites carry two CERES instruments, one operating in a fixed azimuth scanning mode for continuous Earth sampling and the other operating in a rotating azimuth scanning mode (RAPS) for improved Angular Directional Models.

To preserve historical continuity, some parts of the CERES data reduction use algorithms identical with the algorithms used in ERBE. At the same time, many of the algorithms on CERES are new. To reduce the uncertainty in data interpretation and to improve the consistency between the cloud parameters and the radiation fields, CERES includes cloud imager data and other atmospheric parameters. The CERES investigation is designed to monitor the top-of-atmosphere radiation budget as defined by ERBE, define the physical properties of clouds, define the surface radiation budget, and determine the divergence of energy throughout the atmosphere. The CERES Data Management System produces products which support research to increase understanding of the Earth's climate and radiant environment.

[Product Specific Information]

Table of Contents

1.0 Collection Overview

1.1 Collection Identification

The *PSN* filename is

CER_ *PSN*_Sampling-Strategy_Production-Strategy_XXXXX.YYYYMM[DD][HH] where

Sampling-Strategy defines the platform (e.g., TRMM-PFM)
Production-Strategy defines the edition or campaign (e.g., At-launch-Edition)
XXXXXX is a configuration code used for file and software versioning management
YYYY is a 4-digit year integer
MM is a 2-digit month integer
DD is a 2-digit day integer [Modify as needed for monthly products] and
HH is a 2-digit hour integer which defines the data acquisition date.[Modify as needed for daily and monthly products.]

1.2 Collection Introduction

[Product Specific Information]

1.3 Objective/Purpose

The science objectives of the CERES investigation are

1. For climate change analysis, provide a continuation of the ERBE (Earth Radiation Budget Experiment) record of radiative fluxes at the top of the atmosphere (TOA) analyzed using the same techniques as the existing ERBE data.
2. Double the accuracy of estimates of radiative fluxes at the TOA and the Earth's surface.
3. Provide the first long-term global estimates of the radiative fluxes within the Earth's atmosphere.

4. Provide cloud property estimates which are consistent with the radiative fluxes from surface to TOA.

A high-level view of the CERES Data Management System (DMS) is illustrated by the CERES Top Level Data Flow Diagram shown in Figure 1-1. Circles in the diagram represent algorithm processes which are called subsystems. Subsystems are a logical collection of algorithms which together convert input products into output products. Boxes represent archival products. Two parallel lines represent data stores which are designated as nonarchival or temporary data products. Boxes or data stores with arrows entering a circle are input sources for the subsystem, while boxes or data stores with arrows exiting the circles are output products.

[Product Specific Information]

1.4 Summary of Parameters

[Product Specific Information]

1.5 Discussion

[Product Specific Information]

1.6 Related Collections

The CERES DMS produces science data products or collections for use by the CERES Science Team, the Data Management Team, and for archival at the Langley Distributed Active Archive Center (DAAC). For a complete list of products, see the CERES Data Products Catalog (Reference 1).

1.7 Included Collections

[Product Specific Information]

2.0 Investigators

Dr. Bruce R. Barkstrom, CERES Instrument Principal Investigator
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Dr. Bruce A. Wielicki, CERES Interdisciplinary Principal Investigator
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Shade subsystem circle and output product

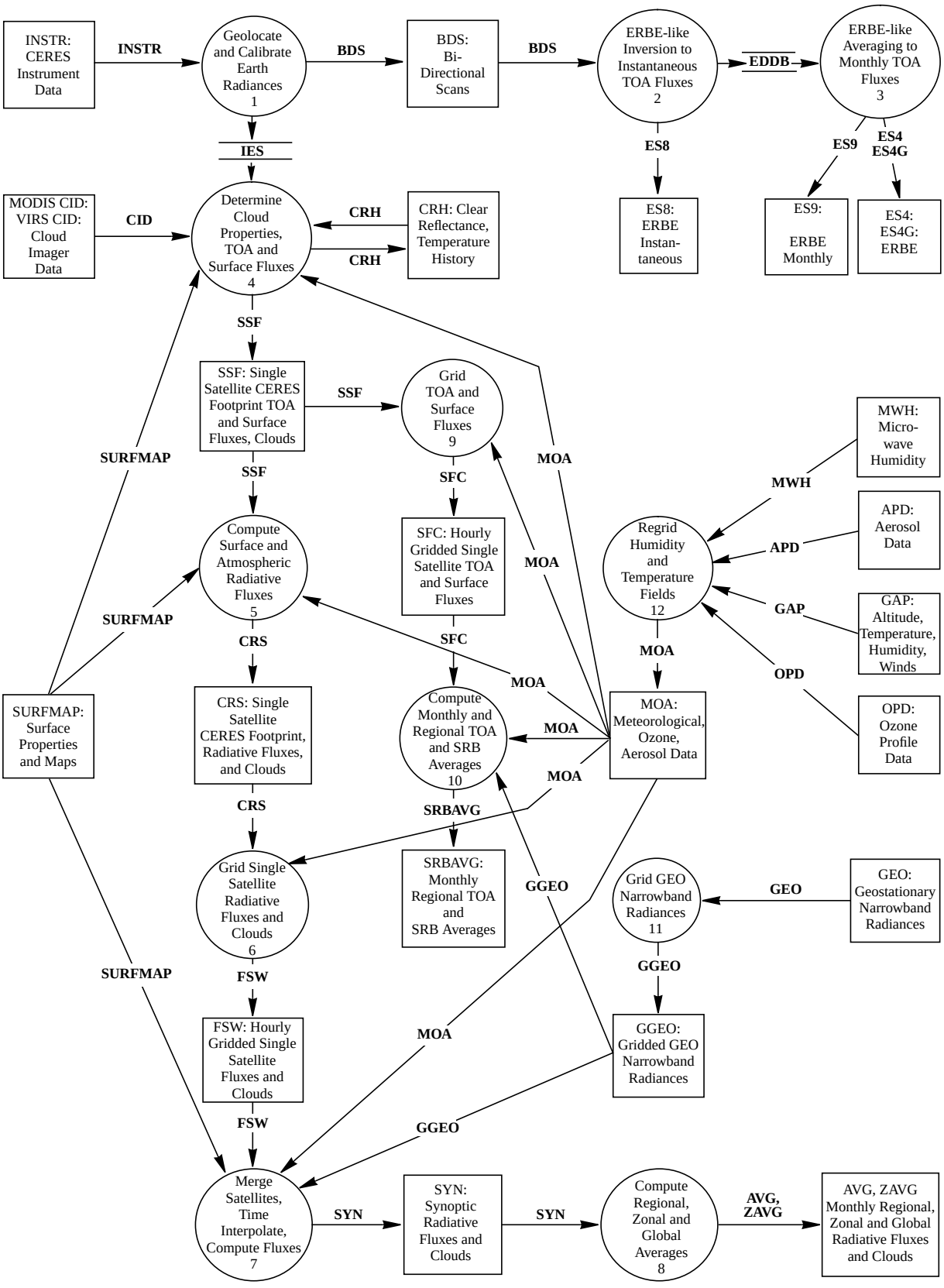

Figure 1-1. CERES Top Level Data Flow Diagram

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Atmospheric Sciences Division
21 Langley Boulevard
NASA Langley Research Center
Hampton, Virginia 23681-0001
FAX: (757) 864-7996

2.1 Title of Investigation

Clouds and the Earth's Radiant Energy System (CERES).

2.2 Contact Information

Working Group Chair Name, Subsystem X Working Group Chair
Mail Stop 420
Atmospheric Sciences Division
21 Langley Boulevard
NASA Langley Research Center
Hampton, Virginia 23681-0001
Telephone: (757) 864-xxxx
FAX: (757) 864-7996
E-mail: *p.q.name*@LaRC.NASA.GOV

3.0 Origination

The CERES data originate from CERES instruments on-board either the TRMM or the EOS Earth-orbiting spacecraft. Table 3-1 lists the CERES instruments along with their host satellites.

Table 3-1. CERES Instruments

Satellite	CERES Instrument	
TRMM	Prototype Flight Model (PFM)	
EOS-AM1	Flight Model 1 (FM1)	Flight Model 2 (FM2)
EOS-PM1	Flight Model 3 (FM3)	Flight Model 4 (FM4)

3.1 Sensor and Instrument Description

The CERES instrument package contains three scanning thermistor bolometer radiometers classified by their broad-band spectral regions: total, window, and shortwave. The detectors measure the radiation in the near-visible through far-infrared spectral region. The shortwave detector measures Earth-reflected solar radiation in the wavelength region of 0.3 to 5.0 microns;

the window detector measures Earth-emitted longwave radiation in the water vapor window wavelength region of 8.0 to 12.0 microns; and the total detector measures radiation in the range of 0.3 to 100 microns. The detectors are coaligned and mounted on a spindle that rotates about the instrument elevation axis. The field of view footprints of the CERES detectors are approximately 10- and 20-km at nadir for the instruments on the TRMM and EOS spacecraft, respectively.

The CERES instrument has an operational scanning cycle of 6.6 seconds and various scan elevation profiles. Radiometric measurements are sampled from the detectors every 0.01 seconds in all scanning profiles. The instrument makes Earth science measurements while the detectors rotate in the vertical (elevation scan) and horizontal (azimuth rotation). The instrument has built-in calibration sources for performing in-flight calibrations, and can also be calibrated by measuring solar radiances reflected by a solar diffuser plate into the instrument field of view. See the CERES Algorithm Theoretical Basis Document (ATBD) for Subsystem 1.0 (Reference 2). Also, see the instrument, the sensor, and the platform Guides (TBD).

4.0 Data Description

4.1 Spatial Characteristics

4.1.1 Spatial Coverage

The CERES collection is a global data set whose spatial coverage depends on the satellite orbit as shown in Table 4-1. *[Product Specific Information]*.

Table 4-1. CERES Spatial Coverage

Spacecraft	Minimum Latitude (deg)	Maximum Latitude (deg)	Minimum Longitude (deg)	Maximum Longitude (deg)	Spacecraft Altitude (km)
TRMM	-52.00	52.00	-180.00	180.00	350
EOS-AM1	-90.00	90.00	-180.00	180.00	705
EOS-PM1	-90.00	90.00	-180.00	180.00	705

4.1.2 Spatial Coverage Map

[Product Specific Information - use postage stamp size images that links to full-sized images - recommendation from DAAC]

4.1.3 Spatial Resolution

[Product Specific Information]

4.1.4 Projection

[Applies to gridded data. Delete section from instantaneous products.]

4.1.5 Grid Description

[Applies to gridded data. Delete section from instantaneous products.]

4.2 Temporal Characteristics

4.2.1 Temporal Coverage

CERES temporal coverage begins at different times depending upon when the spacecraft is launched,when the scan covers are opened after launch, and when early in-orbit calibration check-out is completed (See Table 4-2). Archival science products will be produced for the next complete month of data. *[Product Specific Information]*

Table 4-2. CERES Temporal Coverage

Spacecraft	Launch Date	Start Date	End Date
TRMM	11/27/1997	1/1/98	to present
EOS-AM: FM1 & FM2	Expected 06/30/1998	TBD	to present
EOS-PM: FM3 & FM4	Expected 12/30/2000	TBD	to present

4.2.2 Temporal Resolution

[Product Specific Information]

4.3 Data Characteristics

[Product Specific Information]

4.3.1 Parameter/Variable

The CERES metadata are listed in Table A-1 and Table A-2 in Appendix A. Table A-1 lists the CERES Baseline Header Metadata and Table A-2 lists the parameters in the Vdata Metadata Table. Note that the Vdata Metadata is a subset of the CERES Baseline Header Metadata.

[Product Specific Information] Table of parameters, units, ranges, ... - same as Table in Data Products Catalog.

4.3.2 Variable Description/Definition

[Product Specific Information - a detailed definition of each parameter. If the parameter is copied from a product produced by a previous subsystem, the producing subsystem will define the parameter. All users must have chance to review and approve the definitions. A parameter will be defined only once and will be pulled into each relevant document]

4.3.3 Fill Values

Table 4-3 lists the default CERES Fill Values. These are used when data are missing, when there is insufficient data to make a calculation, or the data are suspect and there is no quality flag associated with the parameter. A value which has a corresponding flag need not be set to the CERES default value when the data value is suspect. Suspect values are values that were calculated but failed edit checks. The CERES default fill values are defined as follows:

Table 4-3. CERES Fill Values

Fill Value Name	Value	Fill Value Description
INT1_DFLT	127	default value for a 1-byte integer
INT2_DFLT	32767	default value for a 2-byte integer
INT4_DFLT	2147483647	default value for a 4-byte integer
REAL4_DFLT	3.4028235E+38	default value for a 4-byte real
REAL8_DFLT	1.7976931348623157E+308	default value for a 8-byte real

4.4 Sample Data Record

[Include 1 sample record with parameter labels or delete section.]

5.0 Data Organization

[Product Specific Information]

5.1 Data Granularity

[Product Specific Information]

5.2 Data Format

[Product Specific Information]

6.0 Theory of Measurements and Data Manipulations

6.1 Theory of Measurements

See CERES ATBD *Subsystem Number*. (Reference 3)

6.2 Data Processing Sequence

[Product Specific Information]

For detailed information see the Subsystem Architectural Design Document. (Reference 4)

6.3 Special Corrections/Adjustments

Algorithms not discussed in the ATBD are discussed in this section.

7.0 Errors

See CERES ATBD *Subsystem Number*. (Reference 3)

7.1 Quality Assessment

Quality Assessment (QA) activities are performed at the Science Computing Facility (SCF) by the Data Management Team. Processing reports containing statistics and processing results are examined for anomalies. If the reports show anomalies, data visualization tools are used to examine those products in greater detail to begin the anomaly investigation. (See the QA flag description for this product.) *{pointer to QA flag description if any contained in product.*

7.2 Data Validation by Source

See Subsystem *Subsystem Number* Validation Document. (Reference 5)

8.0 Notes

9.0 Application of the Data Set

[Product Specific Information]

10.0 Future Modifications and Plans

11.0 Software Description

There is a [Fortran or C] read program available at the DAAC. The program was designed to run on an Unix workstation and can be compiled with a [Fortran77, Fortran90, or C] compiler. *[Correct for fortran or C] {Pointer to DAAC read program}*

12.0 Data Access

12.1 Contacts for Data Center/Data Access Information

EOSDIS Langley DAAC
NASA Langley Research Center
Mail Stop 157D
2 South Wright Street
Hampton, VA 23681-2199
USA
Telephone: (757) 864-8656
FAX: (757) 864-8807
E-mail: larc@eos.nasa.gov
URL:

12.2 Data Center Identification

EOSDIS Langley DAAC
NASA Langley Research Center
Hampton, Virginia 23681-2199

12.3 Procedures for Obtaining Data

{Section supplied by the DAAC}

13.0 Output Products and Availability

{Section supplied by the DAAC - includes packaging for distribution}

14.0 References

1. Clouds and the Earth's Radiant Energy System (CERES) Data Management System Data Products Catalog Release 3 Version 1 February 1998 {URL = http://asd-www.larc.nasa.gov/DPC/DPC.html}
2. Clouds and the Earth's Radiant Energy System (CERES) Algorithm Theoretical Basis Document, Instrument Geolocate and Calibrate Earth Radiances (Subsystem 1.0), Release 2.2, June 1997 {URL = http://asd-www.larc.nasa.gov/ATBD/ATBD.html}
3. Clouds and the Earth's Radiant Energy System (CERES) Algorithm Theoretical Basis Document, Subsystem *Name* (Subsystem *Number*), Release 2.2, *Month* 1997
4. *Subsystem Name* (Subsystem *Number*) Draft Architectural Design Document Release 1.0, June 1996 {URL = http://asd-www.larc.nasa.gov/SDD/SDD.html}
5. *Subsystem Validation Plan Name* Release 1.1, March 1996 {URL = http://asd-www.larc.nasa.gov/validation/valid_doc.html}

15.0 Glossary of Terms

16.0 List of Acronyms

ADM	Angular Distribution Model
APD	Aerosol Profile Data
ATBD	Algorithm Theoretical Basis Document
AVG	Monthly Regional Radiative Fluxes and Clouds
AVHRR	Advanced Very High Resolution Radiometer
BDS	Bidirectional Scan
CADM	CERES Angular Distribution Model
CERES	Clouds and the Earth's Radiant Energy System
CID	Cloud Imager Data
CRH	Clear Reflectance History
CRS	Clouds and Radiative Swath
DAAC	Distributed Active Archive Center
DAO	Data Assimilation Office
DMS	Data Management System
EDDB	ERBE-Like Daily Database Product
EOS	Earth Observing System
EOS-AM	EOS Morning Crossing (Ascending) Mission
EOS-PM	EOS Afternoon Crossing (Descending) Mission
EOSDIS	Earth Observing System Data and Information System
ERBE	Earth Radiation Budget Experiment
ERBS	Earth Radiation Budget Satellite
FOV	Field-of-View
FSW	Monthly Single Satellite Fluxes and Clouds

GAP	Gridded Analysis Product
GB	Giga Byte
GEO	Geostationary Narrowband Radiances
GGEO	Gridded GEO Narrowband Radiances
GMS	Geostationary Meteorological Satellite
GOES	Geostationary Operational Environmental Satellite
H	High
HDF	Hierarchical Data Format
IES	Instrument Earth Scans
IGBP	International Geosphere Biosphere Programme
IMS	Information Management System
INSTR	Instrument
ISCCP	International Satellite Cloud Climatology Project
IWC	Ice Water Content
LaRC	Langley Research Center
L	Low
LM	Lower Middle
LW	Longwave
LWC	Liquid Water Content
MB	Mega Byte
METEOSAT	Meteorological Satellite
MISR	Multi-angle Imaging SpectroRadiometer
MOA	Meteorological, Ozone, and Aerosols
MODIS	Moderate Resolution Imaging Spectrometer
MWH	Microwave Humidity
NASA	National Aeronautics and Space Administration
NOAA	National Oceanic and Atmospheric Administration
OPD	Ozone Profile Data
PSF	Point Spread Function
QA	Quality Assessment
RAPS	Rotating Azimuth Plane Scan
SARB	Surface and Atmospheric Radiation Budget
SBUV-2	Solar Backscatter Ultraviolet/Version 2
SFC	Monthly Gridded Single Satellite TOA and Surface Fluxes and Clouds
SRB	Surface Radiation Budget
SRBAVG	Monthly Averages for Top-of-Atmosphere and Surface Radiation Budget
SSF	Single Satellite CERES Footprint TOA and Surface Fluxes, Clouds
SSM/I	Special Sensor Microwave/Imager
SURFMAP	Surface Map
SW	Shortwave
SYN	Synoptic Radiative Fluxes and Clouds
TBD	To be determined
TISA	Time Interpolation and Spatial Averaging
TMI	TRMM Microwave Imager
TOA	Top-of-the-Atmosphere
TRMM	Tropical Rainfall Measuring Mission

UM	Upper Middle
URL	Uniform Resource Locator
VIRS	Visible Infrared Scanner
WN	Window
ZAVG	Monthly Zonal and Global Radiative Fluxes and Clouds

Unit Definitions

Units	Definition
AU	Astronomical Unit
cm	centimeter
count	count, counts
day	day, Julian date
deg	degree
deg sec^{-1}	degrees per second
du	Dobson units
fraction	fraction 0..1
g kg^{-1}	gram per kilogram
g $^{m-2}$	gram per square meter
hhmmss	hour, minute, second
hour	hour
hPa	hectoPascals
in-oz	inch-ounce
K	Kelvin
km	kilometer, kilometers
km sec^{-1}	kilometers per second
m	meter
mA	milliamp, milliamps
micron	micrometer, micron
msec	millisecond
mW $cm^{-2}sr^{-1}\mu m^{-1}$	milliWatts per square centimeter per steradian per micron
m sec^{-1}	meter per second
N/A	not applicable, none, unitless, dimensionless
percent	percent, percentage 0..100
rad	radian
sec	second
volt	volt, volts

Units	Definition
$W\ h\ m^{-2}$	Watt hour per square meter
$W^2\ m^4$	square Watt per meter to the 4th
$W\ m^{-2}$	Watt per square meter
$W\ m^{-2} sr^{-1}$	Watt per square meter per steradian
$W\ m^{-2} sr^{-1} \mu m^{-1}$	Watt per square meter per steradian per micron
°C	degrees centigrade
μm	micrometer, micron

17.0 Document Information

17.1 Document Revision Date

February 1998 - Original Version

17.2 Document ID

...(supplied by DAAC)

17.3 Citation

...(supplied by DAAC)

17.4 Document Curator

...(supplied by DAAC)

17.5 Document URL

...(supplied by DAAC)

APPENDIX A

CERES Metadata

This section describes the metadata that are written to all CERES HDF products, and are listed in Table A-1 and Table A-2. Table A-1 describes the CERES Baseline Header Metadata that are written on both HDF and binary direct access output science data products. The parameters are written in HDF structures for CERES HDF output products and are written as 80 byte records for binary direct access output products. Some parameters may be written in multiple records. Table A-2 describes the CERES_metadata Vdata parameters that are a subset of the CERES Baseline Header Metadata and are also written to all CERES HDF output products.

Table A-1 lists the item number, parameter name, units, range or allowable values, the data type, and the maximum number of elements. Note that there are two choices for parameters 22-25 and two choices for parameters 26-29. The choices depend on whether the product is described by a bounding rectangle or by a GRing. Abbreviations used in the Data Type field are defined as

s = string	date =	yyyy-mm-dd
F = float	time =	hh:mm:ss.xxxxxxZ
I = integer	datetime =	yyyy-mm-ddThh:mm:ss.xxxxxxZ

Table A-1. CERES Baseline Header Metadata

Item	Parameter Name	Units	Range	Data Type	No. of Elements
1	ShortName	N/A	N/A	s(8)	1
2	VersionID	N/A	0 .. 255	I3	1
3	CERPGEName	N/A	N/A	s(20)	1
4	SamplingStrategy	N/A	CERES, TRMM-PFM-VIRS, AM1-FM1-MODIS, TBD	s(20)	1
5	ProductionStrategy	N/A	Edition, Campaign, DiagnosticCase, PreFlight, TBD	s(20)	1
6	CERDataDateYear	N/A	1997 .. 2050	s(4)	1
7	CERDataDateMonth	N/A	1 .. 12	s(2)	1
8	CERDataDateDay	N/A	1 .. 31	s(2)	1
9	CERHrOfMonth	N/A	1 .. 744	s(3)	1
10	RangeBeginningDate	N/A	1997-11-19 .. 2050-12-31	date	1
11	RangeBeginningTime	N/A	00:00:00.000000Z .. 24:00:00:000000Z	time	1
12	RangeEndingDate	N/A	1997-11-19 .. 2050-12-31	date	1
13	RangeEndingTime	N/A	00:00:00.000000Z .. 24:00:00:000000Z	time	1
14	AssociatedPlatformShortName	N/A	TRMM, AM1, PM1, TBD	s(20)	1 - 4

Table A-1. CERES Baseline Header Metadata

Item	Parameter Name	Units	Range	Data Type	No. of Elements
15	AssociatedInstrumentShortName	N/A	PFM, FM1, FM2, FM3, FM4, FM5, TBD	s(20)	1-4
16	LocalGranuleID	N/A	N/A	s(80)	1
17	PGEVersion	N/A	N/A	s(10)	1
18	CERProductionDateTime	N/A	N/A	datetime	1
19	LocalVersionID	N/A	N/A	s(60)	1
20	ProductGenerationLOC	N/A	SGI_xxx, TBD	s(255)	1
21	NumberofRecords	N/A	1 .. 9 999 999 999	I10	1
22	WestBoundingCoordinate	deg	-180.0 .. 180.0	F11.6	1
23	NorthBoundingCoordinate	deg	-90.0 .. 90.0	F11.6	1
24	EastBoundingCoordinate	deg	-180.0 .. 180.0	F11.6	1
25	SouthBoundingCoordinate	deg	-90.0 .. 90.0	F11.6	1
22	GRingPointLatitude	deg	-90.0 .. 90.0	F11.6	5
23	GRingPointLongitude	deg	-180.0 .. 180.0	F11.6	5
24	GRingPointSequenceNo	N/A	0 .. 99999	I5	5
25	ExclusionGRingFlag	N/A	Y (= YES), N (= NO)	s(1)	1
26	CERWestBoundingCoordinate	deg	0.0 .. 360.0	F11.6	1
27	CERNorthBoundingCoordinate	deg	0.0 .. 180.0	F11.6	1
28	CEREastBoundingCoordinate	deg	0.0 .. 360.0	F11.6	1
29	CERSouthBoundingCoordinate	deg	0.0 .. 180.0	F11.6	1
26	CERGRingPointLatitude	deg	0.0 .. 180.0	F11.6	5
27	CERGRingPointLongitude	deg	0.0 .. 360.0	F11.6	5
28	GRingPointSequenceNo	N/A	0 .. 99999	I5	5
29	ExclusionGRingFlag	N/A	Y (= YES), N (= NO)	s(1)	1
30	AutomaticQualityFlag	N/A	Passed, Failed, or Suspect	s(64)	1
31	AutomaticQualityFlagExplanation	N/A	N/A	s(255)	1
32	QAGranuleFilename	N/A	N/A	s(255)	1
33	ValidationFilename	N/A	N/A	s(255)	1
34	ImagerShortName	N/A	VIRS, MODIS, TBD	s(20)	1
35	InputPointer	N/A	N/A	s(255)	800
36	NumberInputFiles	N/A	1 .. 9999	I4	1

Table A-2 describes the CERES_metadata Vdata parameters which are written to all CERES HDF output science products. The table lists the item number, parameter name, units, range or allowable values, and the parameter data type where

s = string	date =	yyyy-mm-dd
F = float	time =	hh:mm:ss.xxxxxxZ
I = integer	datetime =	yyyy-mm-ddThh:mm:ss.xxxxxxZ

Table A-2. CERES_metadata Vdata

Item	Parameter Name	Units	Range	Data Type
1	ShortName	N/A	N/A	s(32)
2	RangeBeginningDate	N/A	1997-11-19 .. 2050-12-31	s(32)
3	RangeBeginningTime	N/A	00:00:00.000000Z .. 24:00:00:000000Z	s(32)
4	RangeEndingDate	N/A	1997-11-19 .. 2050-12-31	s(32)
5	RangeEndingTime	N/A	00:00:00.000000Z .. 24:00:00:000000Z	s(32)
6	AutomaticQualityFlag	N/A	Passed, Failed, or Suspect	s(64)
7	AutomaticQualityFlagExplanation	N/A	N/A	s(256)
8	AssociatedPlatformShortName	N/A	TRMM, EOS AM-1, EOS PM-1, TBD	s(32)
9	AssociatedInstrumentShortName	N/A	PFM, FM1, FM2, FM3, FM4, FM5, TBD	s(32)
10	LocalGranuleID	N/A	N/A	s(96)
11	LocalVersionID	N/A	N/A	s(64)
12	CERProductionDateTime	N/A	N/A	s(32)
13	NumberofRecords	N/A	1 .. 9 999 999 999	4-byte integer
14	ProductGenerationLOC	N/A	SGI_xxx, TBD	s(256)